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H4F FD30B FD30K FD30N FD31K FD31X FESX

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(54) Video image manipulation; controling anti-alias filter for segmented output image

(57) Input video image data is manipulated, and the manipulated image is segmented into sub-areas with a border between the sub-areas. In order to avoid aliassing due to compression of the image an anti-alias filter is provided controlled by the degree of compression or local scaling factor in a "tile" (a plurality of neighbouring pixels). The local scaling factor is determined, for tiles lying wholly within one sub-area, by comparing the separation of pixels having a predetermined spatial relationship with the tile before and after manipulation. This breaks down in the case of tiles lying across the border between sub-areas, and for those tiles (shaded in figure 5) the scaling factor of individual pixels in a tile are taken as those of the nearest adjacent tile 1, 2, 3, 4 in the same sub-area.

Fig.5.

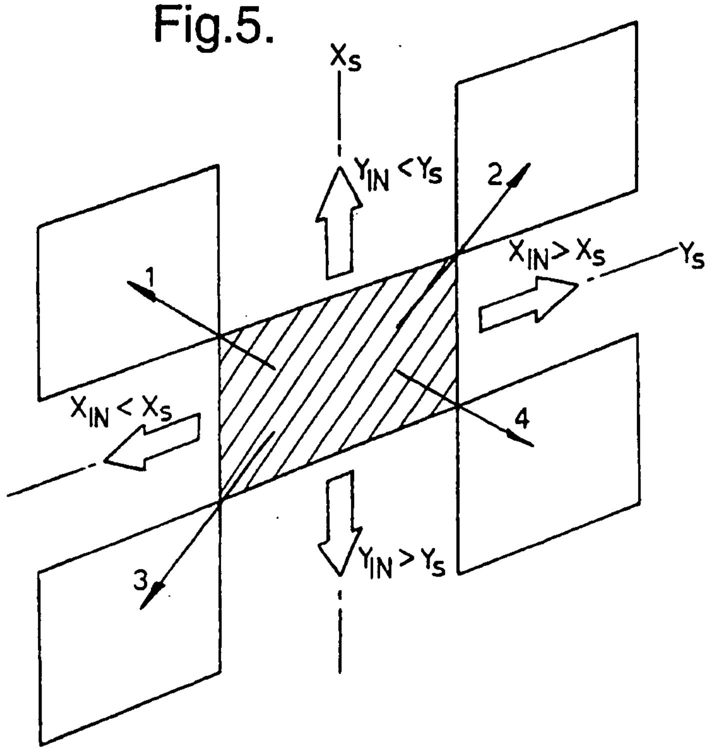

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Fig.1.

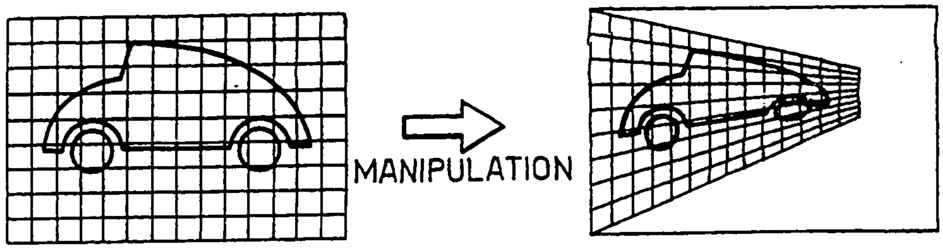


Fig.2.

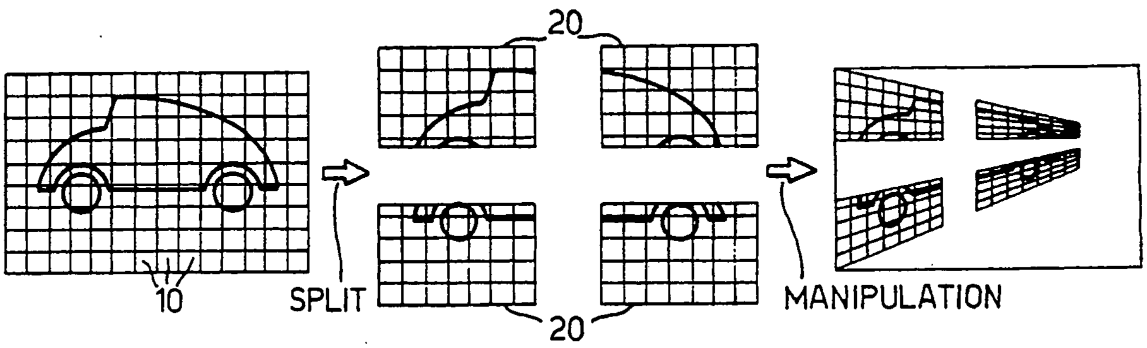


Fig.3.

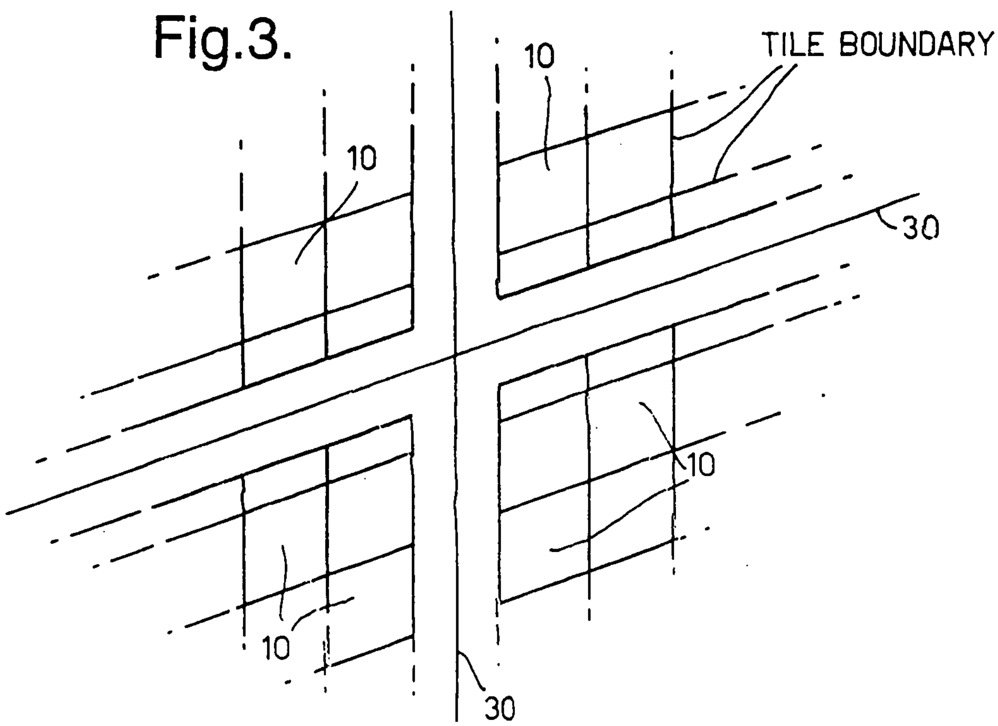


Fig.4.

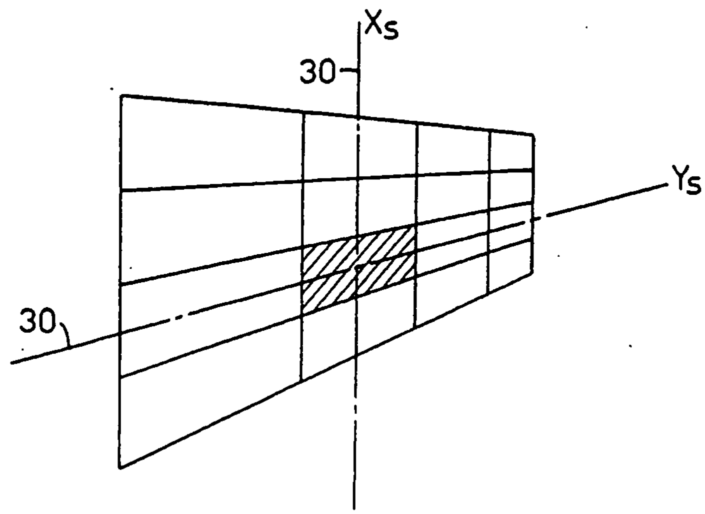


Fig.5.

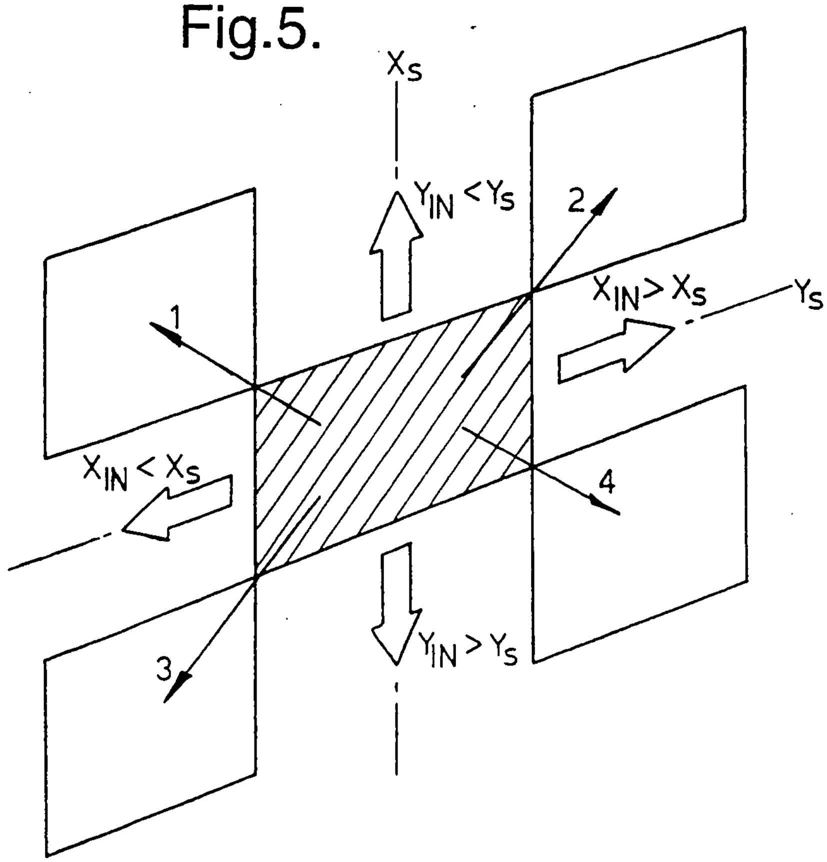


Fig.6A.

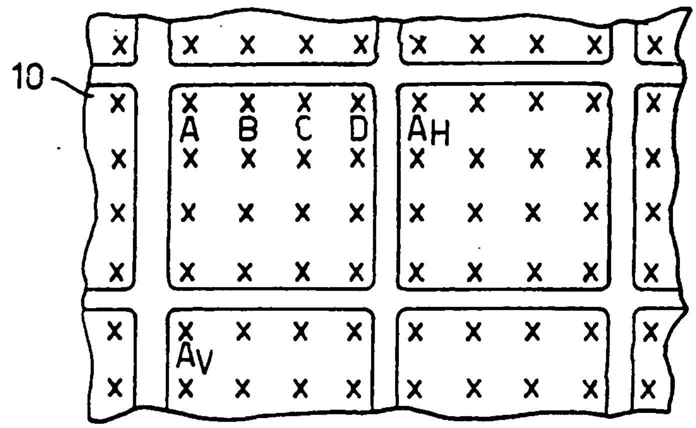


Fig.6B.

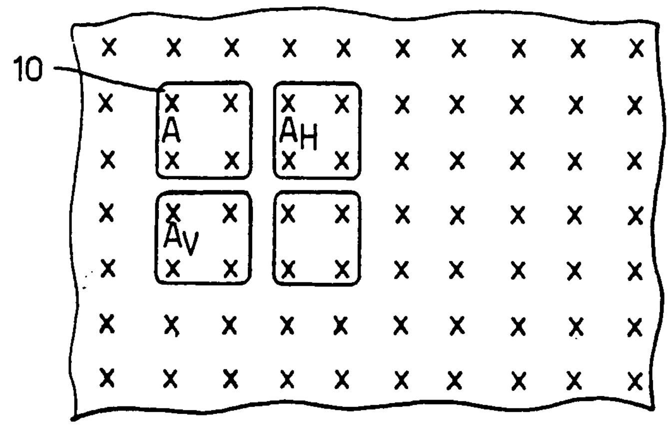


Fig.6C.

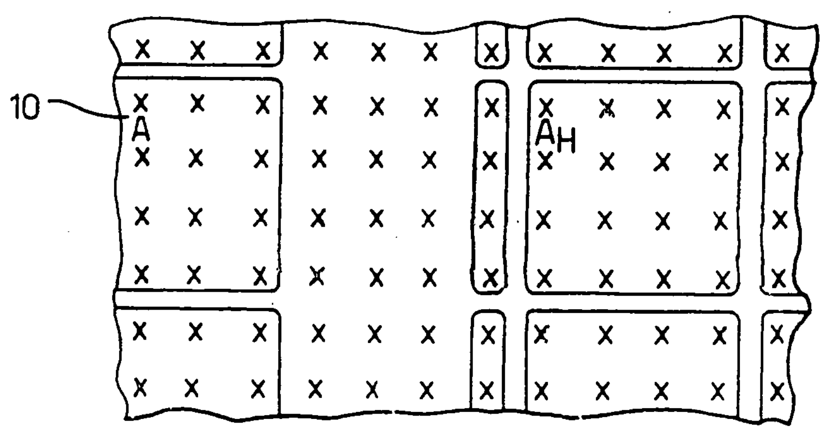


Fig.7A.

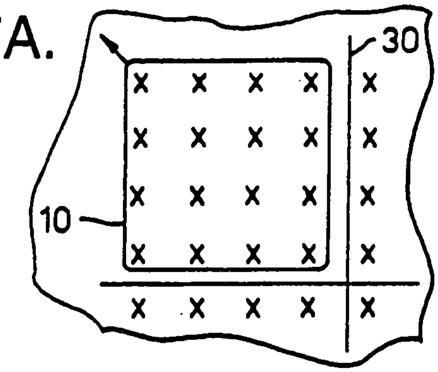


Fig.7B.

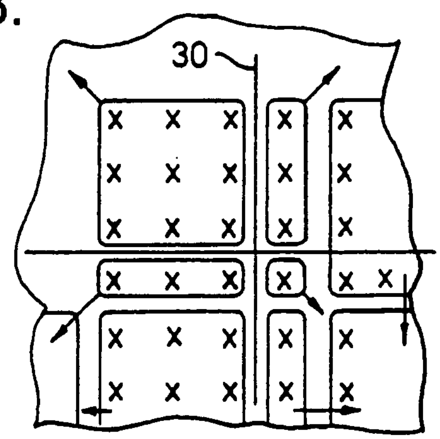
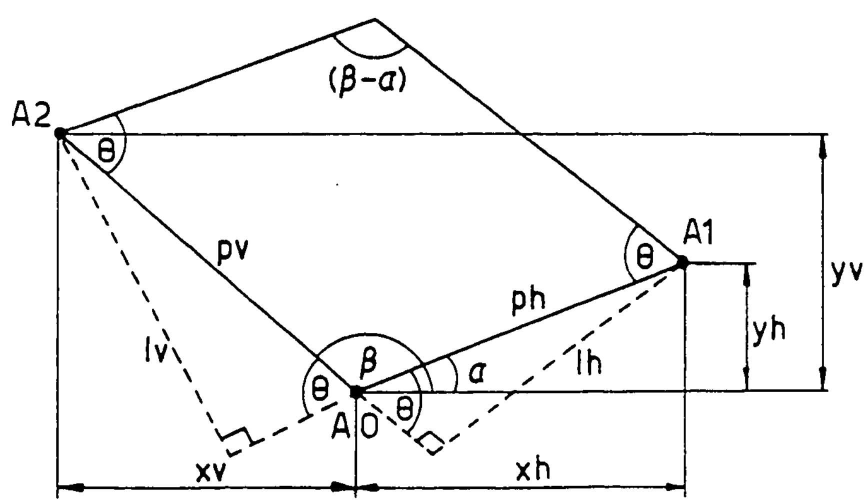


Fig.8.



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ANTI-ALIAS FILTER CONTROL FOR A SPLIT PICTURE

The present invention relates to a method and apparatus for anti-alias filter control for a split picture and more particularly to anti-alias control of an input video image which is to be mapped so as to form an image which comprises the input video image split into a number of segments.

Often video images are manipulated for particular effects, an example of which is illustrated in Figure 1 of the accompanying drawings. However, when an image is manipulated in this way, compression of the image results in aliasing distortion of the image.

It is now contemplated that, during image manipulation, it may be required to split an input image into a number of segments as illustrated in Figure 2 of the accompanying drawings.

It is an object of the present invention to provide a method and apparatus for reducing the effects of aliasing distortion when manipulating an image, in particular, when an image is to be split into segments.

According to the present invention there is provided a method of filtering input video image data representing an input video image, where the input video image data is to be manipulated to form output video image data representing an output video image, where the manipulation includes segmentation of the input video image into sub-areas and

where the output video image comprises at least one of the sub-areas, the input image treated as being made of a plurality of tiles, each tile comprising a plurality of pixels, the method comprising the steps of:

for each of said tiles which is of a first type, calculating local scaling factors representative of the degree to which the tile is compressed by said manipulation by comparing the separation, before manipulation, of pixels having a predetermined spacial relationship with the tile, with the separation after the manipulation, a tile being of said first type when all the pixels having the predetermined spacial relationship with said tile lie in the same sub-area;

for each tile where pixels having the predetermined relationship with said each tile lie in more than one sub-area, selecting, for each individual pixel of said each tile, local scaling factors of the adjacent tile of said first type nearest to said each individual pixel and in the same sub-area as said each individual pixel; and

spacially filtering the pixels of said plurality of tiles in a manner which takes account of said local scaling factors.

According to the present invention there is also provided an apparatus for filtering input video image data representing an input video image, where the input video image data is to be manipulated to form output video image data representing an output video image, where the manipulation includes segmentation of the input video image

into sub-areas and where the output video image comprises at least one of the sub-areas, the input image treated as being made up of a plurality of tiles, each tile comprising a plurality of pixels, the apparatus comprising:

calculating means for calculating, for each of said tiles which is of a first type, local scaling factors representative of the degree to which the tile is compressed by said manipulation by comparing the separation, before manipulation, of pixels having a predetermined spacial relationship with the tile with the separation after the manipulation, a tile being of said first type when all the pixels having the predetermined spacial relationship with said tile lie in the same sub-area;

selecting means for selecting, for each individual pixel of each tile where pixels having the predetermined relationship with said each tile lie in more than one sub-area, local scaling factors of the adjacent tile of said first type nearest to said each individual pixel and in the same sub-area as said each individual pixel; and

filtering means for spacially filtering the pixels of said plurality of tiles in a manner which takes account of said local scaling factors.

The anti-alias filtering may be produced by local scaling factors which are calculated for horizontal and vertical directions based on the horizontal and vertical compressions introduced by the image manipulation. Thus, the image may be divided in the horizontal and vertical

directions so as to form a plurality of tiles, the local scaling factors being determined in both the horizontal and vertical directions and the anti-alias filters being controlled to operate at a "tile level" for the entire image.

Whereas splitting the input image would otherwise result in irregularities in the image as a result of the process of anti-alias filtering, the present invention provides a method by which, despite such splitting, the input image may be appropriately filtered.

The invention will be more clearly understood from the following description, given by way of example only with reference to the accompanying drawings in which:

Figure 1 illustrates an example of known image manipulation;

Figure 2 illustrates a variation of the manipulation of Figure 1 in which the image is split into four segments;

Figures 3 and 4 illustrate split boundaries occurring within image tiles;

Figure 5 illustrates how different areas of a split tile are processed;

Figures 6A to 6C illustrate tiles at a pixel level and their compression and splitting;

Figures 7A and 7B illustrate, at a pixel level, how scaling factors are chosen for tiles effected by a split; and

Figure 8 illustrates the relationship of pixels for the purposes of calculating local sealing factors.

It is known to use an apparatus for video image processing such that an input image which would normally

fill an entire screen may be altered in size and/or processed so as to appear to lie on a three dimensional surface within the screen.

An example of this form of processing is shown in Figure 1 where an image is projected onto a perspective surface extending into the screen. In practice, this may be implemented as a write side system or as a read side system i.e. achieving the image manipulation by writing pixel data to an address different to its original address or reading, for a particular address, pixel data from a different address in the original information.

This processing of the image data results in a compression of the image and aliasing distortion of the resulting image. To overcome this problem, an image processing apparatus is proposed which uses anti-alias filters to appropriately filter the image data prior to manipulation so that, upon manipulation, the aliasing distortion is reduced.

The image is first, at least notionally, divided into "tiles" 10 as shown in the accompanying figures. The width and height of each tile is examined before and after the manipulation so that horizontal and vertical scaling factors may be determined individually for each tile and appropriate band widths set for the horizontal and vertical prefilters.

Figure 6 illustrates a specific example with 4 x 4 sixteen pixel tiles 10 in which the horizontal and vertical scaling factors for tile 10 are calculated by comparing the

spacings of pixels A and A_H and pixels A and A_V respectively before and after manipulation. Considering the horizontal scaling factor in more detail, the spacing between pixels A and A_H before manipulation is clearly the standard four pixel spacing. However, if after manipulation tile 10 has been compressed to half its width, as illustrated in Figure 6B, the spacing between pixels A and A_H is reduced to only two pixels. Such compression may be produced in only the horizontal or only the vertical direction, but as illustrated in Figure 6B, the spacing between pixels A and A_V is also reduced to only two pixels.

Considering calculation of the local scaling factors in more detail, based on the parameters shown in Figure 8, expressions for the local scaling factors may be derived as follows:

$$lh = ph\sin\theta \qquad ph = \sqrt{(xh)^2 + (yh)^2}$$

$$lv = pv\sin\theta \qquad pv = \sqrt{(xv)^2 + (yv)^2}$$

$$\theta = 180^\circ - (\beta - \alpha)$$

$$\sin(180^\circ - (\beta - \alpha)) = \sin(\beta - \alpha)$$

$$\tan\alpha = \frac{-yh}{xh} \qquad \tan\beta = \frac{yv}{-xv}$$

$$\therefore lh = \sqrt{(xh)^2 + (yh)^2}.\ \sin(\beta - \alpha) = f(xh, xv, yh, yv) = LSX$$

$$lv = \sqrt{(xv)^2 + (yv)^2}.\ \sin(\beta - \alpha) = g(xh, xv, yh, yv) = LSY$$

The values for xh and xv are found by calculating the difference in horizontal tile addresses for horizontally and

vertically adjacent tile corners respectively. The values for yh and yv are calculated similarly from the vertical tile addresses.

The values for xh and yh are processed by a rectangular to polar coordinate converter to generate their magnitude and angle α. The magnitude of xv and yv and angle β are generated in the same way.

The value for $\sin(\beta-\alpha)$ is obtained from a look-up table, stored in PROM.

After LSX and LSY are computed, the final filter control data is derived as follows:

For LSF 1, the value is limited to 0x1F (this will select a bypass set of coefficients on the Prefilters, as no anti-alias filtering is required under these circumstances).

For LSF < 1, the value is quantized to 5 bits in the range 0x00 (minimum filter bandwidth) to 0x1E (maximum filter bandwidth). These data values will select 1 of 31 possible low pass filter coefficient sets of the Prefilters.

Therefore, the H and V filters are controlled independently and are applied to all pixels in the tile for which the LSFs are calculated.

Referring to Figure 2, it is also possible to split an input image into a number of segments 20 when manipulating the image to lie on the three dimensional surface.

In the most flexible system, an image can be split at any pixel. However, according to the system described above, if the image is split along a vertical line passing

between pixels C and D, as illustrated in Figure 6C, when the scaling factors are calculated for tile 10, the spacing between A and A_H will have increased to a seven pixel width even though no expansion of the pixel data within tile 10 has occurred. Thus, the process described above for calculating appropriate scaling factors is no longer suitable, since comparison of pixel addresses either side of the split will not give a true indication of compression.

Indeed, the above process is not even suitable for the present system of tiles even when the split occurs along a tile boundary, since the split will still separate pixel addresses used in the calculation of local scaling factors.

A system is now proposed in which, when the local scaling factors of a particular tile would otherwise be calculated incorrectly i.e. pixels used for the calculation of scaling factors for a tile lie in more than one output image segment, the local scaling factors of the pixels of that tile are taken to be those of the adjacent unaffected tile.

It is necessary to decide which local scaling factors are to be used at the split boundary (see Figure 3). This decision is further complicated when the data being manipulated is demultiplexed, in particular due to higher processing rates used for high definition video images used in HDTV.

The strategy proposed relies upon knowing data prior to and in advance of a particular tile being processed and

on determining the scaling factors for a pixel of a split tile to be those of the nearest complete or unsplit tile on the same side of the split boundary e.g. in the same output segment.

Since the split boundary can occur at any pixel, i.e. any phase of the image data, the incoming local scaling factors should be able to be resolved to pixel/phase accuracy to determine which of the nearest complete tiles is to be selected for filtering data near the split boundary.

Figure 4 illustrates the proposed strategy in which the shaded tile denotes the area around the split boundary where it becomes necessary to derive local scaling factors from the nearest complete tiles. The following equations explain the proposed scheme:

If $X_{IN} < X_s$ select tile values before current tile
If $X_{IN} > X_s$ select tile values after current tile
If $Y_{IN} < Y_s$ select tile values before current tile
If $Y_{IN} > Y_s$ select tile values after current tile

Where X_{IN}, Y_{IN} denote the horizontal and vertical addresses for the manipulated image.

Where X_s, Y_s denote the horizontal and vertical split axis.

Figure 5 shows in more detail, the tile area to be

selected for the local scaling factors when the tile region is around the split boundary. The four arrows (labelled 1 to 4) show which tile the local scaling factors will be taken from for the appropriate segments of the shaded tile around the split boundary.

At a pixel level, Figures 7 and 8 illustrate also with arrows which adjacent tiles are chosen to determine the scaling factors for the pixels of an effected tile.

Since the split can occur at any pixel/line and an apparatus can apply this method to demultiplexed video data, as well as non demultiplexed data, it may be required to supply different local scaling factors for each of the demultiplexed phases of data.

CLAIMS

1. A method of filtering input video image data representing an input video image, where the input video image data is to be manipulated to form output video image data representing an output video image, where the manipulation includes segmentation of the input video image into sub-areas and where the output video image comprises at least one of the sub-areas, the input image treated as being made of a plurality of tiles, each tile comprising a plurality of pixels, the method comprising the steps of:

for each of said tiles which is of a first type, calculating local scaling factors representative of the degree to which the tile is compressed by said manipulation by comparing the separation, before manipulation, of pixels having a predetermined spacial relationship with the tile, with the separation after the manipulation, a tile being of said first type when all the pixels having the predetermined spacial relationship with said tile lie in the same sub-area;

for each tile where pixels having the predetermined relationship with said each tile lie in more than one sub-area, selecting, for each individual pixel of said each tile, local scaling factors of the adjacent tile of said first type nearest to said each individual pixel and in the same sub-area as said each individual pixel; and

spacially filtering the pixels of said plurality of tiles in a manner which takes account of said local

scaling factors.

2. A method according to claim 1 wherein said input video image is treated as being divided in horizontal and vertical directions so as to form rectangular and/or square tiles.

3. A method according to claim 2 wherein at least one of the pixels having the predetermined spacial relationship with a tile is at a corner of the tile.

4. A method according to claim 2 or 3 wherein at least one of the pixels having the predetermined spacial relationship with a tile is at the corner of an adjacent tile.

5. A method according to claim 2, 3 or 4 wherein said step of calculating includes comparing the addresses, before manipulation, of pixels having the predetermined spacial relationship with a tile with the separation after said manipulation so as to determine the horizontal and vertical compression of the tile resulting from the manipulation.

6. A method according to any one of claims 2 to 5 wherein each pixel located in said each tile is filtered in a manner which takes account of the vertical local scaling factor of the adjacent tile of said first type nearest to said each pixel and in the same sub-area.

7. A method according to any one of claims 2 to 6 wherein each pixel located in said each tile is filtered in a manner which takes account of the horizontal local scaling

factor of the adjacent tile of said first type nearest to said each pixel and in the same sub-area.

8. A method according to any preceding claim wherein each of said tiles comprises sixteen pixels arranged in four columns and four rows.

9. An apparatus for filtering input video image data representing an input video image, where the input video image data is to be manipulated to form output video image data representing an output video image, where the manipulation includes segmentation of the input video image into sub-areas and where the output video image comprises at least one of the sub-areas, the input image treated as being made up of a plurality of tiles, each tile comprising a plurality of pixels, the apparatus comprising:

calculating means for calculating, for each of said tiles which is of a first type, local scaling factors representative of the degree to which the tile is compressed by said manipulation by comparing the separation, before manipulation, of pixels having a predetermined spacial relationship with the tile with the separation after the manipulation, a tile being of said first type when all the pixels having the predetermined spacial relationship with said tile lie in the same sub-area;

selecting means for selecting, for each individual pixel of each tile where pixels having the predetermined relationship with said each tile lie in more than one sub-area, local scaling factors of the adjacent

tile of said first type nearest to said each individual pixel and in the same sub-area as said each individual pixel; and

filtering means for spacially filtering the pixels of said plurality of tiles in a manner which takes account of said local scaling factors.

10. An apparatus according to claim 9 wherein said input video image is treated as being divided in horizontal and vertical directions so as to form rectangular and/or square tiles.

11. An apparatus according to claim 10 wherein at least one of the pixels having the predetermined spacial relationship with a tile is at a corner of the tile.

12. An apparatus according to claim 10 or 11 wherein at least one of the pixels having the predetermined spacial relationship with a tile is at the corner of an adjacent tile.

13. An apparatus according to claim 10, 11 or 12 wherein said calculating means, in use, compares the addresses, before manipulation, of pixels having the predetermined spacial relationship with a tile with the separation after said manipulation so as to determine the horizontal and vertical compression of the tile resulting from the manipulation.

14. An apparatus according to any one of claims 10 to 13 wherein each pixel located in said each tile is, in use, filtered in a manner which takes account of the

vertical local scaling factor of the adjacent tile of said first type nearest to said each pixel and in the same sub-area.

15. An apparatus according to any one of claims 10 to 14 wherein each pixel located in said each tile is, in use, filtered in a manner which takes account of the horizontal local scaling factor of the adjacent tile of said first type nearest to said each pixel and in the same sub-area.

16. An apparatus according to any preceding claim wherein each of said tiles comprises sixteen pixels arranged in four columns and four rows.

17. A method of filtering an input video image data substantially as hereinbefore described with reference to and as illustrated by the accompanying drawings.

18. An apparatus for filtering an input video image data constructed and arranged substantially as hereinbefore described with reference to and as illustrated by the accompanying drawings.

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Patents Act 1977 Examiner's report to the Comptroller under Section 17 (The Search report)	Application number GB 9323006.8
Relevant Technical Fields (i) UK Cl (Ed.M) H4F (FESG, FESK, FESX, FGM, FGXX, FHD, FHH) (ii) Int Cl (Ed.5) G06F (15.62). HO4N (5/262)	Search Examiner M K REES Date of completion of Search 18 JANUARY 1994
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii) ONLINE DATABASE: WPI	Documents considered relevant following a search in respect of Claims :- 1 TO 18

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E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

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Category	Identity of document and relevant passages	Relevant to claim(s)
A	GB 2244622 A (SONY) see abstract	1,9
A	GB 2231749 A (SONY) see abstract	1,9
A	GB 2183118 A (SONY) see abstract	1,9

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